



FEDERAL INFORMATION  
PROCESSING STANDARDS PUBLICATION  
1978 September 15

U.S. DEPARTMENT OF COMMERCE / National Bureau of Standards



*Guideline*

**FOR  
MANAGING MULTIVENDOR  
PLUG-COMPATIBLE  
ADP SYSTEMS**

**CATEGORY: ADP OPERATIONS  
SUBCATEGORY: MANAGEMENT OF MULTIVENDOR  
ADP SYSTEMS**

JK  
468  
.A8A3  
NO. 56  
1978

**U.S. DEPARTMENT OF COMMERCE, Juanita M. Kreps, *Secretary***  
**Dr. Sidney Harman, *Under Secretary***  
**Jordan J. Baruch, *Assistant Secretary for Science and Technology***  
**U.S. NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director***

## **Foreword**

The Federal Information Processing Standards Publication Series of the National Bureau of Standards is the official publication relating to standards and guidelines adopted and promulgated under the provisions of Public Law 89-306 (Brooks Bill) and under Part 6 of Title 15, Code of Federal Regulations. These legislative and executive mandates have given the Secretary of Commerce important responsibilities for improving the utilization and management of computers and automatic data processing systems in the Federal Government. To carry out the Secretary's responsibilities, the NBS, through its Institute for Computer Sciences and Technology, provides leadership, technical guidance, and coordination of government efforts in the development of technical guidelines and standards in these areas.

To an increasing extent, Federal ADP systems are being configured with components obtained from multiple sources and ADP managers are being provided with services from multiple suppliers. This multivendor environment is a product of procurement policies and contracting practices developed and implemented by GSA. These innovative methods of doing business have had a significant impact on the data processing community by helping to establish a new segment of the ADP industry namely the "independent suppliers." This has led to both increased competition in the marketplace and substantial procurement savings by the Federal Government.

With the advent of the multivendor environment the Federal ADP manager is presented with an entirely new concept in installation management. This document provides guidance for this new management approach with the objective of accomplishing the planning as well as economic acquisition and operation of independently supplied ADP components from multivendor sources.

M. ZANE THORNTON, *Acting Director*  
Institute for Computer Sciences and Technology

## **Abstract**

To an increasing extent, Federal automatic data processing (ADP) systems are being configured with components obtained from multiple sources and ADP managers are being provided with services from multiple suppliers. This multivendor environment has led to both increased competition in the marketplace and substantial procurement savings by the Federal Government. This document is intended for the Federal ADP manager who is responsible for the planning, acquisition, and operation of multivendor ADP systems—particularly multivendor plug-compatible ADP systems. Its main purpose is to facilitate the planning and operation of multivendor systems by providing guidance based upon actual Federal agency experiences with problems in such installations and recommend ways through which they may be resolved.

Key words: ADP systems; multivendor systems; plug-compatible systems; procurement regulations; standards.

Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS PUB) 56, 18 pages,  
(1978)  
CODEN: FIPPAT

---

For sale by the National Technical Information Service, U.S. Department of Commerce,  
Springfield, Virginia 22161



**Federal Information Processing Standards  
Publication 56**

1978 September 15

ANNOUNCING THE



**GUIDELINE FOR MANAGING MULTIVENDOR  
PLUG-COMPATIBLE ADP SYSTEMS**

Federal Information Processing Standards Publications are issued by the National Bureau of Standards pursuant to the Federal Property and Administrative Services Act of 1949 as amended, Public Law 89-306 (79 Stat. 1127), Executive Order 11717 (38 FR 12315, dated May 11, 1973) and Part 6 of Title 15 Code of Federal Regulations (CFR).

**Name of Guideline.** Guideline for Managing Multivendor Plug-Compatible ADP Systems.

**Category of Guideline.** ADP Operations, Management of Multivendor ADP Systems.

**Explanation.** This guideline provides general assistance to Federal ADP managers responsible for the planning, acquisition, or operation of an ADP system that involves products or services obtained from multiple sources. It identifies frequently occurring problems and provides guidance for resolving these problems.

**Approving Authority.** Department of Commerce, National Bureau of Standards (Institute for Computer Sciences and Technology).

**Maintenance Agency.** Department of Commerce, National Bureau of Standards (Institute for Computer Sciences and Technology).

**Cross Index.** None.

**Applicability.** This guideline is intended as a reference document of recommended practices for general use throughout the Federal Government in the planning, acquisition, and operation of multivendor ADP systems.

**Qualifications.** This guideline is based upon the knowledge of a Task Group composed of members from various departments and agencies of the Federal Government, in addition to input received from other sources both within and without the Government.

As new knowledge is gained in the management of multivendor ADP systems, this guideline will be modified accordingly. All comments and recommendations are welcome and will be considered in future revisions. These should be addressed to the Computer Systems Engineering Division, Institute for Computer Sciences and Technology, National Bureau of Standards, Washington, D.C. 20234.

**Where To Obtain Copies of the Guideline.** Copies of this publication are for sale by the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22161. When ordering, refer to Federal Information Processing Standards Publication 56 (NBS-FIPS-PUB-56), and title. When microfiche is desired, this should be specified. Payment may be made by check, money order, American Express Card, or deposit account.



OCT 13 1970

FIPS PUB 56

**Federal Information Processing Standards  
Publication 56**

1978 September 15

SPECIFICATIONS FOR

**GUIDELINE FOR MANAGING MULTIVENDOR  
PLUG-COMPATIBLE ADP SYSTEMS****Contents**

	<i>Page</i>
1. INTRODUCTION .....	5
1.1 Purpose .....	5
1.2 Background .....	5
2. EQUIPMENT ACQUISITION PROCESS .....	5
2.1 Planning .....	5
2.2 Types of Procurements and ADP Contracts .....	6
2.3 Impact of Plug-to-Plug Components .....	8
2.4 Standard of Performance and Acceptance of Plug-to-Plug Components .....	8
3. OPERATIONS-MANAGEMENT CONSIDERATIONS .....	8
3.1 Problem Diagnosis .....	8
3.2 Maintenance .....	9
3.3 Vendor Coordination .....	12
3.4 Recordkeeping .....	13
3.5 Configuration Analysis .....	14
3.6 Site Preparation .....	15
4. SPECIAL CONSIDERATIONS .....	17
4.1 Add-On Memory Problems .....	17
4.2 Magnetic Media Interchangeability .....	17
4.3 Incomplete Documentation .....	17
4.4 Dual Charges .....	18
4.5 Quality of Maintenance .....	18
4.6 Special Adapters .....	18
5. DEFINITIONS OF TERMS .....	19





# 1. INTRODUCTION

## 1.1 Purpose

This guideline is intended to assist Federal ADP managers in solving various problem situations that may be encountered in the planning, acquisition, operation and maintenance of ADP systems involving plug-compatible components acquired from multiple sources. Guidance is provided in terms of the actions suggested for resolving each of the identified problems; in some cases, management procedures are described that may be employed to avoid problem occurrences.

The problems identified by this document along with their associated remedial actions are derived from an assimilation of the records and reported events reflecting approximately 5 years of Government-wide experience. This coverage does not purport to represent an exhaustive treatment of how to successfully manage multivendor ADP systems. Rather, the problems that have been selected for consideration are only those judged to be the most significant and frequently occurring.

## 1.2 Background

The number of multivendor computer systems in the Federal Government is expected to increase as a result of Federal agency use of a family of computer interface standards issued as Federal Information Processing Standards. This guideline provides guidance based on the Federal Government's experience to date in successfully employing multivendor systems, where that has been possible through the use of de facto interface standards, employing General Services Administration requirements contracts for certain classes of peripheral equipment or by other means. It is expected that those agencies currently planning and operating multivendor systems will immediately benefit from use of this guideline, in addition to those agencies that in the future procure and interconnect ADP equipment from multiple sources as a result of application of the planned Federal I/O interface standards.

# 2. EQUIPMENT ACQUISITION PROCESS

## 2.1 Planning

The following issuances are important to the ADP procurement process.

**1. Federal Management Circular FMC 74-5:** provides policies and procedures relating to the selection and acquisition of automated data processing equipment (ADPE).

### **2. Federal Procurement Regulations**

a. FPR Subpart 1-4.11: procures and contracts for Government-wide automated data processing equipment, software, maintenance services, and supplies.

b. FPR 1-1-327-5(b) and 5(c): defines contractor requirements, notification requirements and penalties for violations of the Privacy Act of 1974, Public Law 93-579.

## **3. Part 101-32 of the Federal Property Management Regulations (FPMR).**

a. FPMR 101-32.2: sets forth the requirements and procedures governing the use of existing Government ADP facilities on a shared basis.

b. FPMR 101-32.3: provides the policies and procedures relating to the reutilization of Government-owned and leased excess automatic data processing equipment (ADPE).

c. FPMR 101-32.4: provides the guidance, policies, and procedures that agency officials must consider before initiating procurement of all automatic data processing equipment (ADPE) and related software, maintenance services, and supplies by Federal agencies.

d. FPMR 101-32.13: provides standard terminology for use in purchase agreements, solici-

tations, and offers for the acquisition of ADP related software and services to give effect to Federal Standards announced in FIPS PUBS.

e. FPMR 101-32.17: provides guidelines and definitions for agency services and responsibilities and for contractor responsibilities relating to ADP security requirements and requirements under the Privacy Act of 1974, Public Law 93-579.

#### 4. OMB Circular

a. A-76: provides for maximum practical use of commercial services.

b. A-108: defines the user agency responsibilities for implementing the Privacy Act of 1974, including disclosure accounting, access to records, agency rules, exemptions, and penalties.

## 2.2 Types of Procurements and ADP Contracts

### 2.2.1 Formal Advertising or Negotiation

The Government's policy states that, "All procurements, whether by formal advertising or negotiation, shall be made on a competitive basis to the maximum practical extent." Accordingly, the contracting officer is bound by law to seek competition unless sufficient facts are made available to demonstrate that a valid reason exists to preclude competition. Any procurement action which limits competition must be justified to show why the Government's policy will not be followed. Although Government policy states that the formal advertising procedure is the preferred method for all procurements, most ADP procurements are negotiated because of the difficulty the Government has conveying to all bidders a complete, unvarying understanding of what is required. Accordingly, under negotiated procurements, the two methods used by the Government to satisfy its ADP needs are competitive and noncompetitive (sole source) procurements. These two methods are defined in FPR 1-4.1102-16 and 1-4.1102-17 respectively as follows:

**a. Competitive Procurement.** A "competitive procurement" means that the Government's requirements are set forth in the form of data sys-

tems specifications or equipment performance requirements, a combination thereof, or other unrestrictive specifications which allow full competition and are devoid of bias toward either a specific product or a specific supplier.

#### **b. Noncompetitive (sole source) Procurement.**

A "noncompetitive procurement" means that the Government's requirements are set forth in the form of necessary specifications which are so restrictive that there is only one known supplier capable of satisfying the Government's requirement. Procurements based on specific make and model specifications/purchase descriptions fall in this category, notwithstanding the existence of adequate price competition as defined in FPR 1-3.807-1b.

A justification to support either a contemplated noncompetitive procurement or use of a specific make and model purchase description must address:

1. The intended use or application of the equipment;
2. The critical installation schedule(s) or unique features and/or mandatory requirements, dictated by the intended use, that limit the acquisition to a single source of supply or a specific make and model. (The overriding necessity of these competition-limiting requirements shall be clearly identified.)
3. The fact that no other known or probable source of supply exists for the required equipment, if a sole source procurement is contemplated. (The justification must elaborate on the steps taken which led to this conclusion.)
4. The existence of patent, copyright, or other limitations; and
5. The practical factors which preclude the development of specifications and/or the requirement for competition (see FPR 1-4.1102-16).

### 2.2.2 Types of Contracts

The various types of contractual vehicles available to the contracting officer are described in FPR 1-3.4. However, the main types of fixed price contracts used to acquire ADPE are definite quantity,



requirement-type, and ADP schedules, (as described below).

**a. Definite Quantity Contracts:** provide for a specified quantity of ADPE with deliveries or performance at designated locations. This type of contract is often used to acquire complete systems as well as to replace equipment leased from the manufacturer with identical equipment acquired from a third party leasing market at a lower overall cost to the Government.

**b. Requirements Contracts:** expedite the effective implementation of OMB Bulletin 70-9, through GSA initiated requirements contract program. This program was initiated to assist Federal agencies in acquiring less costly, but functionally identical, peripheral equipment components from independent peripheral manufacturers and other sources in lieu of the original equipment manufacturer. To date, GSA has awarded mandatory requirements contracts for certain peripheral equipment components on a competitive basis. These contracts cover such items as memory units, punched card machine equipment, disk packs, inquiry/communication CRT terminals, disk and tape drives. When ADPE which will satisfy the user's requirements is available from GSA requirements contracts, this source shall be used by all agencies as the primary source to satisfy needs once it has been determined that the requirements cannot be met under FPMR 101-32.2 or 101-32.3. Copies of the contracts (not contractor's price lists) are distributed to the recipients of the schedule FSC Group 70, Part I. Additional copies are available from the General Services Administration (8BR), Building 41, Denver Federal Center, Denver, Colorado 80225. Some of these requirements contracts specify that GSA is responsible for the allocation of the ADPE. In these cases, authorization shall be obtained from General Services Administration (CDP), Washington, D.C. 20405 before placing an order against the requirements contract. Prior to acquiring from another source ADPE that is functionally similar to the ADPE on a requirements contract, the agency shall:

1. document the procurement case file as to why requirements contract could not be used, and
2. obtain a delegation of procurement authority from GSA if the procurement falls outside the scope of FPR 1-4.1103-1.

**c. ADP Schedule Contracts:** cover most types of commercially available ADP equipment negotiated by GSA annually. These contracts are used primarily for the continued rental of maintenance of installed equipment. In addition, they are very useful to agencies in acquiring special features and additional equipment when no other source of supply is capable of meeting an agency's requirements.

There are several advantages to using ADP Schedule Contracts. They are simple to use, administrative procurement costs to the agency are minimal and the acquisition time is very short. However, there are two major disadvantages to such contracts. First, they are not awarded on a competitive basis. Consequently, when they are used to acquire additional equipment, it is, in effect, a sole source procurement. Secondly, the prices, except in isolated cases, are higher than those for identical or similar equipment when acquired as a result of a competitive procurement. Guidance on the use of ADP Schedules is set forth in FPR 1-4.1107-6.

### 2.2.3 Additional Procurement Guidance

In addition to the summary on the previous page, the following guidance is provided for those instances where an entire system or a substantial portion of an entire system is being acquired competitively.

#### a. In cases where:

1. An agency is buying an ADP system using a workload specification and all original equipment manufacturers (OEM) are free to respond, or
2. Total system responsibility has an impact on meeting the workload specifications, or
3. The entire system is priced in a manner such that the subject subsystem(s) cannot be acquired separately.

The agency is then free to acquire the subject subsystem(s) as a part of the larger procurement from sources other than the applicable mandatory requirements contracts.

**b.** In the case where an agency is acquiring all or part of leased ADP systems and a specific brand name or model is identified (e.g., a third party replacement), the applicable peripheral equipment shall be obtained from the mandatory requirements contract. The peripheral equipment will not

be included in the solicitation, except where an economic analysis shows that the presently installed equipment represents a lower overall cost to the Government or the mandatory requirements contract has been determined not to meet the requirement.

c. In the case where an agency is competitively acquiring an initial system based on identification of a specific brand name and model, the applicable peripheral equipment shall be obtained from the mandatory requirements contract. The peripheral equipment will not be included in the solicitation, except when the mandatory requirements contract has been determined not to meet the requirement.

### 2.3 Impact of Plug-to-Plug Components

The impact of plug-to-plug components should be minimal since:

1. The requirements contract warrants that the items offered are plug-to-plug interchangeable with the exact type and model of equipment specified in the contracts.

2. The replacement or add-on units are compatible in all respects with all units, systems, and non-diagnostic programs with which the original units are compatible.

3. The replacement or add-on units, in addition, will perform operating functions in a manner equal to the unit of the type and model with which they are interchangeable.

4. The contractors warrant that, when interfaced with an appropriate system, no degradation of the system will result.

### 2.4 Standard of Performance and Acceptance of Plug-to-Plug Components

Each plug-to-plug requirements contract establishes a standard of performance which must be met before any equipment is accepted by the Government. The acceptance period begins on the installation date and ends when the equipment has met the standard of performance for a specified period of time by operating in conformance with the contractor's effectiveness level specified in the contract.

## 3. OPERATIONS-MANAGEMENT CONSIDERATIONS

### 3.1 Problem Diagnosis

In a single vendor computer installation the difficulty of efficiently diagnosing "system" problems is well known and the frequently employed practice of trial-and-error can be costly in terms of system downtime. But, in a multivendor installation, the consequences of incorrect diagnoses can be more serious. Loss in time due to calling the "wrong" vendor first and the added direct cost of paying for his service call although it was not his fault are often unavoidable in a multivendor operation. Then, the delay of getting a second vendor involved with the potential added loss if it is also not his problem, will impact significantly on the effectiveness of the computer facility. Moreover, the machine state at the time of failure may have been altered by the diagnostic efforts of the vendors.

While system problems also exist in a single vendor installation, the related losses tend to be low by comparison. These losses, both in terms of prolonged periods of downtime as well as the direct cost for vendor services, underscore the need for carefully controlled systematic diagnostic procedures.

Whether or not the maintenance in a multivendor installation is performed by an in-house engineering staff, under a single contract with a third party maintenance firm, through multiple service contracts or by the OEM vendors themselves, the installation manager should have on his staff a technically competent individual to coordinate maintenance activities and particularly diagnostic procedures. Ideally, the coordinator should be familiar with the specific system architecture including the interface characteristics at both the channel and device levels. He should also be familiar



with the system software and the diagnostic routines available from the mainframe vendors. The coordinator's responsibilities include determining in each case which vendor or vendors to call to solve a particular problem. During diagnostic testing, he should be directly involved in order to anticipate the need for and alert maintenance personnel from other vendors so as to avoid the long delays should they be needed.

Experience at many installations has shown that when the diagnostic software runs successfully on any given occasion, the executive operating system may not successfully load. On other occasions, the executive operating system will load but may fail under a heavy workload thus giving the impression of a software failure; when, in fact, the root cause may very well be critical hardware timing. As such experience accumulates in a given installation, an analysis of the maintenance records may reveal that under certain circumstances the diagnostic software is inadequate. The installation manager should consider the need for supplemental diagnostic software. It is highly desirable that diagnostic software be implemented to function under the executive system in an actual production environment whenever possible.

In some instances, the mainframe supplier will not run his diagnostic routines when independently supplied peripheral components are attached to the mainframe. In these cases it would be necessary to acquire **supplemental diagnostic software**. On every occasion that independently supplied peripheral components or subsystems are connected to the configuration, all diagnostic software should be exercised to the maximum extent possible to assure both its adequacy and applicability to the entire system configuration.

The most effective method for minimizing multi-vendor diagnostic problems is to follow systematic steps in each case and to assign appropriate responsibilities at each level. The use of an agency's "standard" form adapted to the particular configuration and needs of the individual installation is strongly recommended to provide an orderly approach to the diagnostic procedure and a consistent record of problems and their solutions. The value of a consistent history of problems cannot be over-emphasized. Not only do these records satisfy the obvious requirements for answering such administrative questions as, how much time had been spent on a problem, who was responsible for its solution and so forth, but also a periodic analysis of such records provides insight into potential total

failure of system components and provides a prognostic aid in forecasting such failures.

## 3.2 Maintenance

There are several methods for having maintenance performed on ADP equipment in a multi-vendor environment:

- a. In-house Maintenance: the customer engineers are actually staffed and paid for by the agency who owns and needs the equipment maintained.
- b. Multivendor Maintenance: each vendor is responsible for the segment of the equipment that his particular company either manufactures or has contracted out the service for maintenance.
- c. Third Party Maintenance: one vendor is responsible for all or a portion of your owned equipment.

In some cases, when equipment is leased, the agency may be constrained to multivendor maintenance. However, for a particular installation a combination of any of the above three types can be effective in not only providing significant cost savings, but even more important in providing the user agency the adequate maintenance necessary to ensure that the equipment is in optimum operational condition. In general, it can be expected that the extent of maintenance support received from any vendor will vary in direct proportion to the vendor's installed investment.

Each of the three types of maintenance has its inherent advantages and disadvantages. Before making the decision as to which method of maintenance should be implemented for an installation, it is recommended that technical specifications as quoted in the contractor's proposal be carefully studied; other agencies with similar configurations which had a past experience or are currently using a particular type of maintenance should be consulted.

### 3.2.1 In-House Maintenance

#### **Advantages:**

1. The in-house Customer Engineers (CE's) can perform the problem determination for the installation since they are responsible for maintenance of all the equipment. It can eliminate the fin-

ger pointing that exists when there are multiple vendors.

2. There is only one group responsible for maintaining the equipment, similar to the situation of having the Original Equipment Manufacturer (OEM) performing maintenance. Therefore the scheduling of preventive maintenance, equipment relocations, and other changes is less complicated. This eliminates multiple calls, and overlapping of preventive maintenance and schedules since there is a single point of contact for these services.

3. The in-house CE is onsite and therefore his response time is immediate to any failure.

4. The in-house CE is apt to be more responsive to the operational needs and schedules of the installation. As a member of the agency's staff he has a closer working relationship with other functional elements (i.e., operations systems and applications in such areas as problem solving, implementing new procedures, recommending system enhancements, etc.).

5. The in-house CE's become more intimately familiar with the installation's hardware configuration and any specialized equipment arrangements; therefore they will provide more "specialized maintenance." This is possible because the CE's are responsible for only the particular agency's installation, and do not have the responsibility for calls for another installation's equipment.

6. Flexibility is enhanced since it is not necessary to renegotiate a maintenance contract or agreement each time the equipment is added or the production schedule is modified.

7. Record keeping and reporting of maintenance activities and equipment performance are more apt to fit site requirements when carried out by an in-house maintenance staff. In contrast when maintenance is provided by a contractor, additional costs for the record keeping and reporting needs of the site will be incurred.

#### **Disadvantages:**

1. Significant initial capital investment is required for tools and parts and sufficient documentation to maintain the equipment, as well as recur-

ring expenses for salaries and administrative support.

2. Maintenance of an adequate parts level, supplies, and engineering changes can be a problem. This is partly due to the fact that maintaining the proper levels is very costly, and partly because the OEM response to the critical needs is not always adequate.

3. The training level of the CE's is the responsibility of the agency, consequently the acquisition of new types of equipment requires additional training and sometimes personnel.

4. Additional cost is incurred when the OEM must inspect the equipment prior to reverting to any other type of maintenance.

5. Recruiting and maintaining competent personnel can be a problem. It is not always easy to distinguish a competent CE through his resume alone. Further investigations should be made regarding his experience and his competency.

6. The OEM has significantly more staff depth from which to seek assistance for very difficult problems. It may be difficult to get such assistance if the in-house maintenance group cannot solve the problem.

7. In-house maintenance requires authorization of full-time personnel positions within existing manpower ceilings.

#### **3.2.2 Multi-Vendor Maintenance**

##### **Advantages:**

1. The CE's of different vendors are technically more familiar with their own equipment and consequently can perform remedial and preventive maintenance more timely and thoroughly.

2. Since the different vendors are responsible for maintenance of only their own equipment, they are more knowledgeable concerning the adequate parts levels, usage and any engineering changes.

3. The different vendors, because they are in a competitive business environment, are motivated to compete and maintain their equipment in opti-



mum operational condition. Additionally, there is the monetary consideration that future business opportunity may be obtained by providing outstanding services.

#### **Disadvantages:**

1. Problem determination must be performed by the agency's personnel which represents an additional cost in salaries. In addition, as the number of vendors increases, the problem diagnosis phase takes increasingly longer, and thus resulting in extended outages.

2. Plug-compatible suppliers may not always possess the adequate resources that the OEM possesses, these include "qualified" CE's, research and development facilities, software support, and specialized expertise.

3. Due to relatively high capital costs some vendors may not maintain recommended adequate levels of spare parts locally.

4. Often, the use of multivendors places an additional administrative burden on the agency since additional time and manpower are required to determine accurate use of time, downtime, maintenance credits and extra maintenance charges.

5. In order to maximize the productivity of each vendor's CE, work space for the storage of parts, tools, technical reference manuals and other documentation would be necessary, requiring additional facility costs for the installation.

#### **3.2.3 Third Party Maintenance**

##### **Advantages:**

1. There are potential initial cost savings to the agency in terms of the contractual costs of having one vendor responsible for all the equipment.

2. The third party CE's can perform the problem determination for the installation since they are responsible for the maintenance of all the equipment. It can eliminate the finger pointing that exists when there are multiple vendors.

3. A higher percentage of up-time can be required contractually and maintenance credits and

incentives can be established to ensure every effort is made on the part of the vendor to keep the equipment in optimum operational condition.

4. Since one vendor is responsible for most of the equipment, less scheduled downtime may be required for preventive maintenance. The importance of this aspect grows with the number of vendors.

##### **Disadvantages:**

1. The response time from the OEM, if necessary, for service in addition to the time already expended by the third party vendor. Additionally there may be an added cost in having to call the OEM for service.

2. The third party vendor must rely on the different equipment manufacturers for spare parts; consequently, the proper parts may not always be available locally. This causes extended downtimes simply awaiting parts.

3. The third party vendors may not always possess the adequate resources that the OEM possesses, such as qualified CE's, research and development facilities, software support, and specialized expertise.

4. Additional cost is incurred when the OEM must inspect the equipment prior to reverting to any other type of maintenance.

5. The third party vendor must rely on the OEM for up-to-date diagnostic routines and technical data. Because of proprietary rights, etc., these may not always be readily available.

#### **3.2.4 Selection of Maintenance Options**

To begin selection of an option most suitable for an installation, several initial questions must be answered. The single most critical problem of managing a multivendor environment is **problem determination/resolution**. The questions that must be answered are:

- (a) "Is the technical expertise available within the agency (or can be provided for) to effectively coordinate any of the various maintenance options?"

- (b) "Are there adequate recordkeeping facilities available for monitoring performance and subsequent issuing of maintenance credits, and/or incentive payments?"

After the requirements are satisfactorily provided for, other details such as response time requirements, overlapped preventive maintenance schedules, principle periods of maintenance, etc. should be investigated and contractually required. Depending upon the usage of the agency's systems, various levels of on-site coverage and on call coverage should be determined. In problem determination/resolution, preventive maintenance, and engineering modifications providing for an overlap of vendors rather than sequential performance should be coordinated.

When planning to migrate from one mix of maintenance to another, sometimes as a result of add-on equipment, there are several aspects that should be investigated. The initial cost savings associated with selecting this new mix for equipment maintenance must be weighed against the factors listed below:

- (a) The long-term operational consequences involved such as heating, ventilating and air conditioning (HVAC), spatial gains or losses; and power consumption.
- (b) Additional costs incurred in order to administer the mix, whether it be the additional salaries of the agency staff, the contracting of a technical consultant to aid in problem determination, or even the additional time required of agency staff in meetings attempting to control the performance of the vendors.
- (c) Consideration should be given to the options the vendor can provide and the associated costs. Does the contract provide user safeguards in the event of vendor problems? What kind of experience does the vendor have? What is the vendor's skill levels, parts availability, repair facilities, reliability, etc.? With regard to contractor maintenance, the quality and nature of support is best controlled through the terms of the service contract itself. Failure to prepare clear and effective contract provisions can lead to serious problems or misunderstanding during the performance of contracted maintenance services.

### 3.3 Vendor Coordination

Often times problem *determination/resolution* results in the sequential calling of vendors, and in turn extensive downtimes. It is apparent that in this environment an effective method of controlling and monitoring the performance of the vendors is essential. Several methods have proven successful for a multivendor installation to control maintenance of the equipment by the vendors. One is to establish *regularly* scheduled individual vendor meetings. A second is to schedule separate *implementation and coordination* meetings which are attended jointly by all vendors involved with the proposed change. Still another method is the *implementation and use of software packages* designed for monitoring equipment performance. The manager responsible for operations, or his representative should convene and preside over these regularly scheduled vendor meetings. The frequency may vary from weekly meetings in the case of a large organization to bi-monthly meetings for the smaller user. It is vitally important that these meetings be held on a regular basis; it is equally important that regular attendees be established so that a continuity is established through discussions of problems and then reporting of subsequent resolutions/suggestions. The vendor meetings should be scheduled with a single vendor at a time. A recommended method of meeting with the vendors is to do so serially on a particular day; e.g., Vendor A at 9:00 a.m., Vendor B at 9:30 a.m., and Vendor C at 10:00 a.m. The advantage of having the vendors meet serially is that the operational problems and requirements for a particular timeframe can be presented to all the vendors.

To provide the necessary technical expertise and "right" personnel to achieve the effective interaction, several functional areas should be represented in these meetings. As stated earlier the operations manager or his designated representative should preside over the meeting. Additionally, individuals from the installations problem determination, systems, and software areas should be in attendance. The vendor personnel attending these meetings should consist of a representative from marketing and a representative from the customer engineering force (preferably the on-site or assigned CE). In some instances the user agency or the vendor may choose to bring additional personnel to the meeting either for orientation to the in-



stallation or to present specialized information concerning the installations problems and/or resolutions. The user agency may request the attendance of a responsible official from any vendor if the agency feels it is warranted due to persistent problems.

Any topics relevant to the agency's operational environment, and the relationship to the specific vendor's equipment and performance are appropriate discussion items. One of the initial topics of the meeting should be the review of the problems presented at the previous meeting and the resulting actions taken by either the vendor and/or the agency. After this review, other discussion items of importance might include: machine downtime statistics, hardware failures and the problem determination methods, software problems relating to the hardware, preventive maintenance schedules, engineering changes, software changes, and other specialized machine time requests. Additional discussions of proposed system reconfigurations and any future equipment installations can also be presented. The key to a successful vendor meeting is an open exchange of ideas, information and constructive criticism all channeled toward the goal of providing the installation with optimum performance of the equipment. These vendor meetings also present an opportunity to schedule implementation and coordination meetings.

In addition to the vendor meetings, the installation should maintain a calling roster for each vendor for reporting problems. As a given period of downtime extends, the problem should be reported to the vendor's successively higher levels of responsibility. This type of reporting will assure that the vendor's management will become aware of serious problems when appropriate and should thereby improve responsiveness.

The **implementation** and **coordination** meetings are needed so that future changes to the system configuration are presented to all the vendors simultaneously. Not only should the appropriate vendors be represented at this meeting, but all of the agency's personnel involved with the equipment change should also be present. Items to be discussed at the meeting should include:

- (a) time requirements to complete the job,
- (b) sequence of vendors and agency personnel performing the task,

(c) vendors which have diagnostic time and the schedule of when, and

(d) user software time requirements for the change.

At the completion of the session, each vendor should understand exactly what his interface will be during the installation change. The effective use of these two methods will provide the user agency with a good basis for controlling each of the vendors associated with the installation. The key is to open the communication lines both ways, to and from the vendors.

There are several **software packages** that can be utilized to aid in vendor coordination. Basically, these packages analyze data generated by the operating systems software and produce management information reports concerning the performance of the installation's equipment. These reports can be given to the vendors to aid in tracking existing problems as well as potential problems. More importantly, however, the agency can determine from the reports how well the equipment is performing compared to other installations for the particular devices. This generates an incentive for the vendor to either raise or continually improve the level and quality of his service. As the number of vendors increases, the need for closer coordination may require additional in-house technical staff and exceptionally detailed recordkeeping.

### 3.4 Recordkeeping

There is a vital need to keep accurate, timely, and complete records of systems reliability in any ADP installation. There is an even greater need in a multivendor environment because of reluctance of vendors to admit to problems with their products (i.e., finger pointing). Recordkeeping is time consuming and costly, but essential, if an efficient installation is the objective. These records are even more important if it becomes necessary to take contractual action to discontinue a vendor for non-performance.

The recording of data concerning ADP installation reliability can be accomplished via job accounting and system performance routines that are part of the operating system, via hardware and/or software monitors and via manually prepared records. If such records are kept, applica-

tion programs are available commercially and within the Government that can produce system reliability reports. A periodic summary report should be distributed internally at the agency installation and also a copy must be made available to the maintenance vendor(s). These reports are very effective tools in the management of a multi-vendor installation.

It is necessary to have clear delineation of authority within the installation for recording and reporting system's reliability. Periodically, this authority should be reviewed for duplication and/or missing elements.

Following, in outline form, are representative types of records and reports needed for management of multivendor installations. As this outline is not exhaustive, some installations will find the need to keep additional records while others will find it unnecessary to keep all of those suggested.

**NOTE:** All records should be maintained by individual component and maintenance contractor. When applicable, all records should be time and date stamped. If applicable, reports should be of the time series type.

#### 3.4.1 Reliability

- a. Degradation of Device Type by Vendor
- b. Failure of Device Type by Vendor
- c. Degradation of Total System (i.e., partial system failure)
- d. Failure of Total System
  - Downtime—From-To by Times and Date(s)
  - Cold Starts—When All Work in System Is Lost
  - Warm Starts—Partial Loss of Work in System
- e. Job Rerun Because of System Problems—Time, Date, Cause and Resources Used
- f. Preventive Maintenance by Vendor, Time and Date, Start and Stop

The above data is needed to calculate management statistics relating to Mean Time Between

Failures (MTBF), Mean Time to Repair (MTTR) and other system availability figures. When appropriate, report contractor's requirements versus actual performance.

#### 3.4.2 Vendor Responsiveness

- a. Time and Date Vendor Notified of Problem
- b. Time and Date Vendor Responded to Problem
- c. Time and Date Vendor Fixed Problem
- d. Multiple Customer Engineer Support if Required
- e. MTTR Problems by Vendor

Specific problems by vendor should be summarized and reviewed periodically to identify trends and establish frequency of occurrence and recurrence.

#### 3.4.3 Special Provisions

- a. Modification Needed Because of Multivendor Requirements (Time, Date and Reason)
- b. Age and Use of Magnetic Media
- c. Multiple-Vendor Billing for Single Incident
- d. Billing for Efforts of Vendor Outside of Principle Period of Maintenance Because of Multiple-Vendor Problems
- e. Field Engineering Changes (Date, Time, and Vendor)

### 3.5 Configuration Analysis

When reconfiguring a computer system with a different vendor's hardware to either replace existing components, or to add-on to the present configuration several aspects must be considered. The primary consideration during the initial installation should be to install the new equipment in a manner that allows for ease in reverting to the original configuration. This approach is not strictly a multivendor idiosyncrasy, but an industry norm even for single vendor installations. This ensures for maximum flexibility to enable the continuity



of the operation in the event that a crisis arises during the installation phase of the new equipment. There are situations when these precautions are not possible, but every effort must be made to minimize the risks of unscheduled system failures. The simplest method is to install the new equipment without removing the old. This is not always possible as in the case of replacement of core for the central processing units (CPU's).

If space is at a premium, an alternative method of phasing in equipment can be used. For example, instead of installing a  $1 \times 8$  disk drive configuration, install a  $1 \times 2$  configuration in parallel with the existing disks. After successful installation and partial conversion of data, install the remaining 6 disk drives. This approach can be phased-in over a pre-determined period without the loss of operational time and provides for a least risk situation.

### 3.5.1 Configuration Analysis Checklist

Each vendor has available equipment specification manuals and physical planning manuals. These documents provide the data necessary for determining physical layouts. The following chart presents a checklist of some of the important considerations for the reconfiguration of equipment.

Cable Length Restrictions	<ul style="list-style-type: none"> <li>• Use Equipment Specification Manual for each specific vendor's equipment.</li> </ul>
Spatial Relationships	<ul style="list-style-type: none"> <li>• Ensure that service clearances such as door swings, drawer clearance, and gate swings, etc. are allowed for in the physical planning drawings.</li> <li>• Placement of equipment should allow for efficient operating conditions.</li> </ul>
Channel Priorities	<ul style="list-style-type: none"> <li>• Establish priorities through benchmarks with similar equipment configurations.</li> <li>• Software specialists should configure for optimum channel balancing to provide maximum throughput.</li> </ul>
Special Features	<ul style="list-style-type: none"> <li>• Special features can be installed which extend the cable length</li> </ul>

restrictions, usually the vendor can inform you of any such available features.

- The vendor's equipment may have special features which extend the potential of the equipment, or provide technological innovations for the type of equipment installed.
- In the majority of the cases where vendors claim plug-to-plug compatibility, they should provide any necessary connectors and adapters.

Cable  
Connectors  
(Special  
Adapters)

### 3.6 Site Preparation

In a single vendor environment the OEM normally handles all of the physical planning specifications for an agency's computer installation. In a multivendor installation, it is now the responsibility of the user agency to prepare a physical layout and ensure that the site facilities are adequate in terms of the requirements of the equipment to be installed. Each of the respective vendors has available a machine specification and physical planning document, which the user agency should obtain. The information provided in these documents generally supplies the necessary data to perform any calculations concerning physical installation of the equipment. The following items are essential requirements for installing equipment for either replacement or for additions to the present configurations.

#### *Plans*

- It is important that the final copy of the mechanical, electrical and architectural plans be reviewed with each vendor and concurred upon before construction begins.

#### *Flooring*

- It is important that the weight of the equipment alone as well as that of the planned configuration is analyzed against the loading requirements of the raised floor and base floor upon

which the raised floor sits. Such an analysis would point out the areas where structural support might be necessary.

- Due to special cooling requirements, special perforated panels may be necessary if the area below the raised floor is used as an air plenum.
- During installation or relocation of equipment, movement of heavy devices across the floor may cause additional point and/or rolling loads sufficient to damage the tiles even to the extent of crashing through the floor. To preclude this situation, it is recommended that plywood or metal sheets be placed on the raised floor surface when moving heavy equipment.
- Raised floor panels with the proper cable cutouts must be provided for the computer equipment. The location for the cutouts should be positioned in relationship to the actual location of the components.

### ***Power***

- The machine's physical planning guide provides the electrical service requirements for each type of device with regard to: amperes, voltage, ac or dc, phasing, number of wires, kVA and types of plug and receptacle needed (e.g., 100 A, 208 V ac, 3 phase, 4 wire, 1.06 k VA).
- Certain computer components may require specialized power such as 400 cycle service. The agency must then decide whether to use a motor generator or a solid state frequency converter to provide this type of power.

### ***Cooling and Humidity***

- Specific ambient room temperatures and humidity levels required for operations are explained

in the manufacturers physical planning manuals. The agency must analyze the facility to determine that the heating and ventilation systems are adequate to accommodate the increase or decrease in Btu generation, as well as the hot and cold spots generated through placement of the equipment.

### ***Lighting***

- When installing or reconfiguring equipment, ensure that adequate light is available overhead to provide for maintenance and operation.
- Care should be taken to avoid the glare from the lighting on plexiglass or shiny metal surfaces.

### ***Chilled Water***

- Some computer components require chilled water for the dissipation of heat. Special provisions for plumbing, emergency drainage, underfloor water detection units and water chillers are required in these cases.

### ***Noise Levels***

- In accordance with FPMR 101-32.704-3, "The noise level in the computer room shall not exceed 90 decibels without provisions for adequate protection for the personnel in the computer room. Periodic checks should be made with a decibel meter to determine the actual noise level. When a noise problem has been identified, the GSA building manager, or other official controlling or operating the building, shall be contacted for remedial action. Special precautions, based upon competent professional advice, should be required for employees with a hearing impairment."

## 4. SPECIAL CONSIDERATIONS

This section includes a checklist of problems associated with multivendor installations and their solutions. Major problem areas that have been reported by multivendor computer installations are listed below and where solutions exist they are included.

### 4.1 Add-On Memory Problems

Failures in memory power supplies are extremely critical and can jeopardize the total operation of a computer installation. One of the most prevalent causes of power supply failures are utility fluctuations and/or commercial outages.

It is recommended, therefore, that the add-on vendors provide a minimum of one spare power supply for each model or type memory installed in a computer installation as part of the local stock inventory.

Regarding spare parts, an important point to consider is that the quality control between vendors may not be equal. Situations arise where spare parts fail and an emergency order is placed for a new part which upon arrival is also found to be defective. Spares can be tested at the factory and become defective in shipment, or they may test satisfactorily on-site and still fail when required to replace a failing component. One solution is to maintain an adequate level of spares on-site and also be aware of delivery points and delivery schedules for obtaining out-of-stock parts. In addition, it is a good practice to have the vendor test spare parts during preventive maintenance periods and other appropriate times.

After an add-on memory is installed by an independent supplier, the OEM may require inspection of his mainframe. Because of critical timing relationships, testing should be performed after an independent vendor has installed add-on memory to determine if the new memory is within timing specifications. A cost is usually incurred by the user for each inspection required to bring the memory boxes to an OEM specified level.

When add-on memory results in a multivendor memory configuration, it is recommended that the resident operating system be allocated to the OEM memory. It is further recommended that for diagnostic and maintenance purposes each vendor's memory be contiguous. Adequate maintenance support in any installation is directly related to how strong the maintenance requirements contract is written. In many cases the add-on memories may not be maintained by either the OEM or

the independent supplier. To assure adequate customer engineering support, it is recommended that memory performance be closely monitored and frequent coordination meetings be held with the appropriate vendors.

Occasionally, an installation may consider it necessary to switch memory units from one CPU to another. Unless there are no other alternatives, this practice is **not recommended** because it would necessitate retiming and reinspection of the memory units. In addition, experience in such cases indicates potential failure rate similar to those associated with brand new installations.

### 4.2 Magnetic Media Interchangeability

Occasionally, interchangeable media such as magnetic disk or tape recorded on one vendor's equipment cannot reliably be read on the other vendor's equipment. Usually one vendor's equipment is out of tolerance and requires diagnosis and recalibration. In extreme cases, it may be necessary to copy all data from one vendor's equipment to the other vendor's equipment. It is very important that the faulty equipment be identified as soon as possible and necessary repairs and/or adjustments be made. A common calibration media (e.g., magnetic tape and disk) is strongly recommended. Further, maintenance diagnostic procedures should be implemented to check for compatibility among devices.

### 4.3 Incomplete Documentation

Responsibility for recording maintenance data rests with the installations operating personnel. This is not their primary concern when jobs are aborting and hardware is malfunctioning. As a result, inaccuracies and omissions are quite prevalent. Frequently, maintenance personnel enter incomplete and illegible entries. This can result in not being able to identify the vendor and customer engineer responsible for correcting the failing condition. It is recommended that a hardware malfunction and maintenance monitoring procedure (manual or automatic) be established. If a manual



procedure is to be employed, it is recommended that installation and vendor personnel be required to print all entires.

An installation that has third party maintenance must be careful to ensure that accurate equipment documentation, including engineering drawings, is maintained at all times. It is particularly important that the third party vendor be aware of all OEM engineering changes and that they are properly documented and maintained. When an inspection of the system is performed, either by the user, the OEM, or a third party vendor, all maintenance and engineering documentation should be inspected and updated, as necessary.

#### 4.4 Dual Charges

In a single vendor installation, the vendor is contacted immediately upon determination that an equipment failure is suspected. The vendor would run diagnostics on all equipment, if needed, and remain on-site until the failure is resolved. If the problem were operating system software then the vendor's field engineering support personnel would assist the installation's technical software support group in resolving the problem. The result of a single vendor's involvement from the inception of the problem to the subsequent solution is a single charge to the agency.

In a multivendor environment, the situation changes dramatically. The responsibility of problem determination becomes more significant. Additional analysis may be necessary to attempt to isolate the problem before calling the vendor whose equipment is suspected. With an illusive problem many vendors may have to be called before the ultimate solution is found. Each vendor that is called on the scene and states that there was no indication of a hardware malfunction in his equipment is classified as a "no trouble found" incident (NTF) and under normal circumstances, is a billable call.

Reduction in the number of different vendors called, resulting in multiple charges to the agency, can be accomplished by ***building expertise in the area of problem determination***. An operator or supervisor may be assigned this responsibility or the installation manager may establish a special technical staff, whose primary responsibility would be that of problem determination.

#### 4.5 Quality of Maintenance

The quality of maintenance is directly proportional to the competence of the personnel performing the service. Vendors have a general tendency to assign their most competent customer engineers to large accounts. It is, therefore, important that installation managers insist upon the following as a minimum from the vendors with regard to the maintenance service for their installation:

- a. Competent customer engineers to maintain equipment at the level specified in the maintenance contract.
- b. When trainees are performing routine service and preventive maintenance, they must always be supervised and accompanied by experienced maintenance personnel.
- c. At least one competent CE with a sufficient number of experienced backup personnel is always available.

#### 4.6 Special Adapters

Although equipment may be stated as plug-to-plug compatible, the installation manager must ensure that the independent supplier is responsible to supply and connect any special adapters required, including special adjustments. The physical planning manual provided by the independent vendor should include information on all special adapters.



## 5. DEFINITIONS OF TERMS

The following definitions of certain terms are included herein to facilitate the reading of this document. Unless a term is marked by "\*", the definitions are those given in "X3/TR-1, AMERICAN NATIONAL DICTIONARY FOR INFORMATION PROCESSING," 1977 September, which is adopted as a Federal Information Processing Standard (FIPS PUB 11-1, 1977 September 30). The reader is referred to X3/TR-1 for further definitions as may be required.

### ***Available Time***

- (1) The time during which a functional unit can be used.
- (2) Synonymous with uptime.
- (3) Contrast with maintenance time.

### ***Corrective Maintenance***

- (1) Maintenance specifically intended to eliminate an existing fault.
- (2) Contrast with preventive maintenance.

### ***Corrective Maintenance Time***

Time, either scheduled or unscheduled, used to perform corrective maintenance.

### ***Deferred Maintenance***

Maintenance specifically intended to eliminate an existing fault, which did not prevent continued successful operation of the device or computer program.

### ***Diagnostic***

Pertaining to the detection and isolation of a malfunction or mistake.

### ***Downtime***

The time during which a functional unit is inoperable due to a fault.

### ***Emergency Maintenance***

Maintenance specifically intended to eliminate an existing fault, that makes continued production work unachievable.

### ***Emergency Maintenance Time***

Time, usually unscheduled, used to perform emergency maintenance.

### ***Equipment Failures***

Failures necessitating repairs, adjustments or replacements on an unscheduled basis.

### ***Hardware***

- (1) Physical equipment used in data processing, as opposed to programs, procedures, rules, and associated documentation.
- (2) Contrast with software.

### ***Installation Time***

Time spent in installing and testing hardware and software.

### ***Maintenance***

Any activity, such as tests, measurements, replacements, adjustments, and repairs, intended to eliminate faults or to keep a functional unit in a specified state.

### ***Maintenance Time***

- (1) Time used for hardware maintenance. It includes preventive maintenance and corrective maintenance.
- (2) Contrast with available time.

### ***Makeup Time***

- (1) That part of available time used for reruns due to faults or mistakes in operating.
- (2) Contrast with development time.

### ***Marginal Check***

Synonym for marginal test.

### ***Mean-Time-Between-Failures (MTBF)***

For a stated period in the life of a functional unit, the mean value of the lengths of time be-

tween consecutive failures under stated conditions.

***Mean-Time-To-Repair (MTTR)***

The average time required for corrective maintenance.

***Operating Hours\****

That portion of the total time meter hours which is not logged to maintenance.

***Preventive Maintenance***

(1) Maintenance specifically intended to prevent faults from occurring. Corrective maintenance

and preventive maintenance are both performed during maintenance time.

(2) Contrast with corrective maintenance.

***Principal Period of Maintenance\****

The period of maintenance when all calls other than NTF's (No Trouble Found) are non-billable. The NTF's become a billable call for certain vendors when the actual malfunction of the system is determined to be that of another vendor.

---

\* Definitions not contained in "X3/TR-1, AMERICAN NATIONAL DICTIONARY FOR INFORMATION PROCESSING," 1977 September, which is adopted as a Federal Information Processing Standard (FIPS PUB 11-1, 1977 September 30).

# NBS TECHNICAL PUBLICATIONS

## PERIODICALS

**JOURNAL OF RESEARCH**—The Journal of Research of the National Bureau of Standards reports NBS research and development in those disciplines of the physical and engineering sciences in which the Bureau is active. These include physics, chemistry, engineering, mathematics, and computer sciences. Papers cover a broad range of subjects, with major emphasis on measurement methodology, and the basic technology underlying standardization. Also included from time to time are survey articles on topics closely related to the Bureau's technical and scientific programs. As a special service to subscribers each issue contains complete citations to all recent NBS publications in NBS and non-NBS media. Issued six times a year. Annual subscription: domestic \$17.00; foreign \$21.25. Single copy, \$3.00 domestic; \$3.75 foreign.

Note: The Journal was formerly published in two sections: Section A "Physics and Chemistry" and Section B "Mathematical Sciences."

### DIMENSIONS/NBS

This monthly magazine is published to inform scientists, engineers, businessmen, industry, teachers, students, and consumers of the latest advances in science and technology, with primary emphasis on the work at NBS. The magazine highlights and reviews such issues as energy research, fire protection, building technology, metric conversion, pollution abatement, health and safety, and consumer product performance. In addition, it reports the results of Bureau programs in measurement standards and techniques, properties of matter and materials, engineering standards and services, instrumentation, and automatic data processing.

Annual subscription: Domestic, \$11.00; Foreign \$13.75

## NONPERIODICALS

**Monographs**—Major contributions to the technical literature on various subjects related to the Bureau's scientific and technical activities.

**Handbooks**—Recommended codes of engineering and industrial practice (including safety codes) developed in cooperation with interested industries, professional organizations, and regulatory bodies.

**Special Publications**—Include proceedings of conferences sponsored by NBS, NBS annual reports, and other special publications appropriate to this grouping such as wall charts, pocket cards, and bibliographies.

**Applied Mathematics Series**—Mathematical tables, manuals, and studies of special interest to physicists, engineers, chemists, biologists, mathematicians, computer programmers, and others engaged in scientific and technical work.

**National Standard Reference Data Series**—Provides quantitative data on the physical and chemical properties of materials, compiled from the world's literature and critically evaluated. Developed under a world-wide program coordinated by NBS. Program under authority of National Standard Data Act (Public Law 90-396).

NOTE: At present the principal publication outlet for these data is the Journal of Physical and Chemical Reference Data (JPCRD) published quarterly for NBS by the American Chemical Society (ACS) and the American Institute of Physics (AIP). Subscriptions, reprints, and supplements available from ACS, 1155 Sixteenth St. N.W., Wash., D.C. 20056.

**Building Science Series**—Disseminates technical information developed at the Bureau on building materials, components, systems, and whole structures. The series presents research results, test methods, and performance criteria related to the structural and environmental functions and the durability and safety characteristics of building elements and systems.

**Technical Notes**—Studies or reports which are complete in themselves but restrictive in their treatment of a subject. Analogous to monographs but not so comprehensive in scope or definitive in treatment of the subject area. Often serve as a vehicle for final reports of work performed at NBS under the sponsorship of other government agencies.

**Voluntary Product Standards**—Developed under procedures published by the Department of Commerce in Part 10, Title 15, of the Code of Federal Regulations. The purpose of the standards is to establish nationally recognized requirements for products, and to provide all concerned interests with a basis for common understanding of the characteristics of the products. NBS administers this program as a supplement to the activities of the private sector standardizing organizations.

**Consumer Information Series**—Practical information, based on NBS research and experience, covering areas of interest to the consumer. Easily understandable language and illustrations provide useful background knowledge for shopping in today's technological marketplace.

*Order above NBS publications from: Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.*

*Order following NBS publications—NBSIR's and FIPS from the National Technical Information Services, Springfield, Va. 22161.*

**Federal Information Processing Standards Publications (FIPS PUB)**—Publications in this series collectively constitute the Federal Information Processing Standards Register. Register serves as the official source of information in the Federal Government regarding standards issued by NBS pursuant to the Federal Property and Administrative Services Act of 1949 as amended, Public Law 89-306 (79 Stat. 1127), and as implemented by Executive Order 11717 (38 FR 12315, dated May 11, 1973) and Part 6 of Title 15 CFR (Code of Federal Regulations).

**NBS Interagency Reports (NBSIR)**—A special series of interim or final reports on work performed by NBS for outside sponsors (both government and non-government). In general, initial distribution is handled by the sponsor; public distribution is by the National Technical Information Services (Springfield, Va. 22161) in paper copy or microfiche form.

## BIBLIOGRAPHIC SUBSCRIPTION SERVICES

The following current-awareness and literature-survey bibliographies are issued periodically by the Bureau:

**Cryogenic Data Center Current Awareness Service.** A literature survey issued biweekly. Annual subscription: Domestic, \$25.00; Foreign, \$30.00.

**Liquified Natural Gas.** A literature survey issued quarterly. Annual subscription: \$20.00.

**Superconducting Devices and Materials.** A literature survey issued quarterly. Annual subscription: \$30.00. Send subscription orders and remittances for the preceding bibliographic services to National Bureau of Standards, Cryogenic Data Center (275.02) Boulder, Colorado 80302.

**U.S. DEPARTMENT OF COMMERCE**  
**National Technical Information Service**  
5285 Port Royal Road  
Springfield, Virginia 22161

OFFICIAL BUSINESS

POSTAGE AND FEES PAID  
U.S. DEPARTMENT OF COMMERCE  
COM-211

**3rd Class Bulk Rate**

